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Agricultural management mitigates catchment soil erosion under future climate change

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Climate change together with increasing agricultural intensification impact directly on runoff, soil erosion and sediment transport from hillslopes to streams, with potentially adverse consequences for aquatic environments. Previous studies of climate change and soil erosion largely neglect the combined effects of climate and land use changes, tend to lack prior model validation, and contain limited spatial representation of agricultural management practices. Here, we present a novel methodology that addresses these limitations to evaluate the impact of climate change on catchment soil loss and to assess the effect of agricultural practices in mitigating potential impacts. We employ an ensemble of future climate simulations (UKCP09) with a new catchment-scale soil erosion model, MMF-TWI, designed for use in humid agricultural landscapes. MMF-TWI offers a balance between the spatio-temporal representation of soil erosion processes with data and computational requirements. These model characteristics enable assessment of uncertainty in climate and land use projections as well as the identification of spatially-targeted measures to mitigate impacts. Projected soil erosion and sediment yields are simulated in four UK catchments in typical upland and lowland environments from 2010 to 2099 under different agricultural management scenarios, including changes in the extent of arable land, crop rotation, tillage practices, grass field margins, and afforestation. Taking into account uncertainty in future climate change projections and land use spatial arrangements, periods of statistically significant sediment delivery change are identified. Compared to the baseline scenario (1961-1990), we show that past agricultural management practices such as single crop rotations have a much larger impact on soil loss and sediment delivery than projected climate change. In upland moorland environments, the climate change impact can be largely mitigated by the planting of riparian woodland buffers. For lowland environments, conservation tillage and grass margins around arable fields are the most and least effective measures, respectively. Finally, we show that the identification of vulnerable areas using MMF-TWI can improve the longer-term efficiency of mitigation measures.